ZSM-based Orchestration for Inter-Administrative Domain Cross-Border Vehicular Scenarios

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***Abstract*—Beyond 5G networks demand the transition from automated to autonomous network management to decrease human intervention and improve the end-to-end network efficiency. ETSI Zero-Touch Network and Service Management (ZSM) group proposes a service-based architecture to achieve this end. One integral element of such architecture is the Integration Fabric (IF). This demonstration proposes and shows an architecture for the IF element, which enables inter-administrative domain orchestration operations in multiple management domains under the control of different service providers thought up for cross-border vehicular scenarios. These management domains are constituted by a standard ETSI NFV-based Management and Orchestration stack, hence we also demonstrate integration of original NFV work with those proposed by the ZSM architecture.**

I. Introduction

5G networks introduced the needs of network automation capabilities to manage the delivery of end-to-end (E2E) services to vertical customers relying on network function virtualization (NFV) and network slicing paradigms. This is tackled by the framework proposed by the ETSI NFV ISG group. Beyond 5G networks require further automation capabilities, transitioning towards autonomous systems based on closed-loop (CL) control to decrease human intervention and improve network efficiency [1]. To achieve this, the ETSI Zero-Touch Network and Service Management (ZSM) group proposes a service-based management architectural solution [2].

In this architectural approach, the operation is structured around management domains (MDs) (e.g., radio access network MD, core network MD, transport network MD, edge MD) providing a set of management services, implemented as RESTful HTTP-based APIs. These MDs communicate and interact with each other by means of the integration fabric (IF), thus enabling the required E2E view. The ongoing standardization efforts of ETSI ZSM are still at an early stage and based on a high level of abstraction. So, envisioning practical ZSM deployment scenarios are a way forward for identifying challenges and providing viable solutions [3].

The aim of this demonstration is to propose and show an architectural approach enabling the integration of an MD using the standard ETSI NFV Management and Orchestration (NFV-MANO) component within the ZSM architecture. This integration is challenging due to the not service-based nature of standard ETSI NFV MANO interfaces, as identified in [4]. Additionally, this demonstration also shows for the first time an ETSI ZSM-based architecture enabling the interaction with MDs of independent service provider domains through the IF element, hence extending the ETSI ZSM architecture scope. Furthermore, this architecture considers the existence of external services, named enablers. They are entities assisting currently deployed network services and interact with the IF to trigger CL operations on the NFV-MANO based MDs among administrative domains (ADs). This architectural approach can be particularly beneficial in Cooperative, Connected and Automated Mobility (CCAM) scenarios for cross-border situations, such as those proposed by the 5G-ROUTES European project [5], to trigger orchestration operations (e.g., network service relocation) based on vehicle positions.

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II. System Architecture

Fig.1 presents the experimental setup deployed in the CTTC 5G Lab facilities[1]. In this setup, there are two different ADs, each one counting with an independent 5Growth MANO stack [6] based on ETSI NFV-MANO specifications. This MANO stack allows the deployment of Network Services (NSs) and their virtual network functions at the underlying infrastructure composed by different Points of Presence (PoPs). These NFV-MANO stacks constitute different MDs as defined within the ETSI ZSM architecture [2].

One aspect of this demonstration focuses on the design of the depicted IF to enable inter cross administrative domain interactions and the use of the different orchestration-related operations exposed by the available 5Growth MANO stacks, as detailed in the next section. As mentioned before, this scheme goes beyond the scope of ETSI ZSM architecture, which only considers operations within different management domains in a single AD. The IF is based on a Message Queuing Telemetry Transport (MQTT) broker enabling asynchronous messaging following the publish/subscribe (pub/sub) pattern. Messages exchanged in the broker are organised into two main topics. One topic is to address intra-AD operations (i.e., within the same administrative domain) and the other is for inter-AD operations (i.e., to interact with the remote administrative domain). In turn, each topic is divided into two sub-topics to exchange information about operation requests and its associated result. The depicted *Service adapter* module communicates with these resulting four sub-topics to process

[1]Elements represented with solid blocks and lines are the actual demoed elements, while elements with dashed blocks and lines are work in progress.

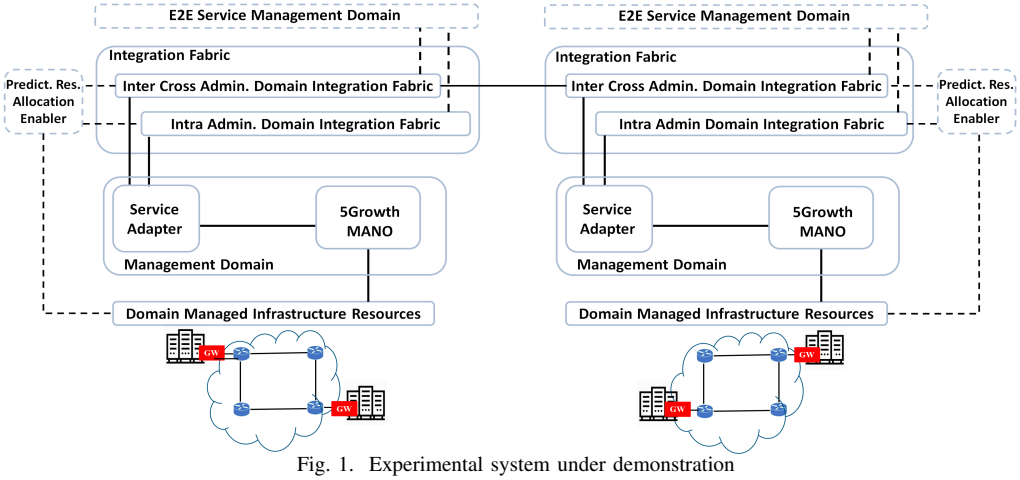

Fig. 1. Experimental system under demonstration

the requested orchestration operations and to publish the associated operation results, that is, translating the NFV-specific communication into ZSM and vice versa. For each received request, the Service Adapter spawns a separate process to allow concurrent requests. The messages published in the request sub-topic contain three common sub-fields required by the Service Adapter module to process operations[2]. One sub-field is the *operationId* identifier, which allows to tag requests and responses to be filtered if issued by different service consumers (e.g, external enablers). The second relevant sub-field is the *domainId* identifier, which allows identifying the AD processing a request and filtering accordingly to answer to the intra-AD or inter cross-AD topic request when needed. The third relevant sub-field is the *serviceId*, which allows identifying the required action to be processed by the appropriate MD within a single administrative domain.

III. Demonstration

This demonstration shows the capabilities of the designed IF to handle different orchestration requests addressing MDs based on an ETSI NFV-MANO stack available in different administrative domains. The IF can provide support to external entities, or enablers, to perform closed-loop orchestration decisions suitable for cross-border vehicular scenarios. In this case, we consider the existence of a *proactive resource allocation enabler*, whose main aim is to provide deployed NSs with *follow me* capabilities, so new NS instances can be deployed in advance when users are going to cross the border and require to continue the use of NSs in another AD (e.g., other mobile network operators). To support the workflow of this enabler, the Service Adapter module offers the following operations:

1) *GetNFVIresourcesService*: it collects the resource availability (e.g., CPU, RAM, Storage) of the different NFVI-PoPs under the control of the NFV-MANO stack. Resource availability at the different ADs is possible by publishing the corresponding message in the corresponding IF topic.

2) *GetNSDInfoService*: it provides information about available (previously onboarded) network services that can be deployed by the MANO stack. This information presents the global resource consumption and the resource consumption of its different constituent VNFs (e.g. CPU, RAM, Storage).

3) *GetNSinstancesInfoService*: it collects information about the NSs deployed by a MANO stack based on their status (i.e., instantiated or terminated).

4) *CreateNSService*: it triggers the instantiation of a new NS associated to the triggering vehicular use case. The request directed to this service accepts a *location* field to specify the NFVI-PoP where to instantiate the required new NS instance. Depending on the topic receiving this request, the NS will be deployed in one AD or other. Possible locations will be determined by the mentioned external enabler entity based on the information provided by the 1) operation.

5) *TerminateNSService*: it triggers the termination of the NS service associated to the vehicular use case (e.g., when all users have migrated from one side of the border to the other).

During the demonstration, messages to the different sub-topics of the IF are sent through Python scripts. These messages are processed by the Service Adapter module at the different MDs and triggers the mentioned operations. The Graphical User Interfaces (GUIs) of the 5Growth platform at the different ADs mainly shows the result of operations 4) and 5) at the Domain managed infrastructure resources segment, as depicted in Fig. 1.

[2]Based on the operation like NS onboarding, instantiation or termination, additional content is required in the messages circulating in the sub-topics

References

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